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(54) SYSTEM AND MODULES FOR COMMUNICATION

SYSTEM UND MODULE FÜR KOMMUNIKATION

SYSTÈME ET MODULES DE COMMUNICATION

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Description

Technical Field

[0001] The disclosure generally relates to the field of data communication, in particular to a system for communication.

Background Art

[0002] US 2012/217658 A1 describes a multi-stack semiconductor integrated circuit device where communication between semiconductor chips can be carried out by bypassing a number of chips. Each semiconductor chip that forms a multi-stack semiconductor integrated circuit device has a stack structure where semiconductor chips having the same shape are stacked on top of each other. A coil for transmission/reception for communication between chips over a short distance is suggested.

[0003] EP 22844849 A1 describes an arrangement for wireless power supply and information communication between electronic circuit substrates in an electronic equipment. The goal of this arrangement is to reduce size of the device.

[0004] EP 2733739 A2 describes an integrated circuit package with a lead frame. The lead frame may comprise a first conductor having a first conductive loop and a second conductor galvanically isolated from the first conductor. The second conductor includes a second conductive loop proximate to and magnetically coupled to the first conductive loop to provide a communication link between the first and second conductor.

[0005] WO 2008/134889 A1 describes a configuration for transmitting an electric signal between electronic devices with a first coupling element electromagnetically coupled to, and immediately juxtaposed to, a second coupling element.

[0006] Currently, communication between a basic function module and an extended function module in a communication system is implemented by using a standard serial peripheral interface (SPI). In the communication system 100, connectors (for example, SPIs 130-1, 130-2, ..., 130-N) usually need to be used for physical connections between a basic function module 110 and an extended function module 120 and between two adjacent extended function modules (for example, between extended function modules 120-1 and 120-2, between extended function modules 120-2 and 120-3, ..., and between extended function modules 120-N-1 and 120-N), as shown in Fig. 1. In this case, it is inconvenient for the user to connect or disconnect the connectors. In addition, since the connections are wired connections, a connection between a high-voltage module and a low-voltage module is forbidden for the sake of safety. Thus, the types of extended function modules suitable for being connected for communication will be restricted. For example, when the basic function module is a high-voltage module, an extended function module must also be a high-voltage

module, and when the basic function module is a low-voltage module, an extended function module must also be a low-voltage module.

5 Summary of the Invention

[0007] In view of this, the disclosure provides a system and modules for communication. By using the system provided by the disclosure, installing near-field communication transceiver units respectively on the basic function module and extended function modules and using the antenna units realized by loop antennas on printed circuit boards to implement near-field communication, near-field communication between the basic function module and an extended function module and between extended function modules can be implemented, without any necessity of using connectors for wired communication.

[0008] The invention is defined by the subject-matter of independent claims 1 and 10. Preferred embodiments are defined in the dependent claims.

[0009] By using the system provided by the disclosure, installing near-field communication transceiver units respectively on the basic function module and extended function modules and using the antenna units realized by loop antennas on printed circuit boards to implement near-field communication, near-field communication between the basic function module and an extended function module and between extended function modules can be implemented, without any necessity of using connectors for wired communication.

[0010] By using the system provided by the disclosure and configuring the first loop antenna and the second loop antenna into wiring loops formed by performing loop wiring along two side edges of corresponding printed circuit boards, the distance between the near-field communication antenna units on two adjacent function modules can be kept within a set communication distance, and in addition interference caused by other function modules during communication between two adjacent extended function modules can be reduced.

[0011] By using the system provided by the disclosure and configuring the first loop antenna and the second loop antenna to have the same/a similar loop shape and/or to be parallel to each other, the communication effect between two adjacent function modules can be improved.

[0012] By using the system provided by the disclosure and determining the sizes and/or shapes of the first loop antenna and the second loop antenna according to the set communication distance, the near-field communication effect between two adjacent function modules can effectively be improved.

[0013] By using the system provided by the disclosure, arranging the first near-field communication antenna unit and the second near-field communication antenna unit along a line and arranging the distance between the near-field communication antenna units on two adjacent func-

tion modules within the set communication distance, near-field communication between two adjacent function modules can be implemented and the communication effect between two adjacent function modules can be improved.

[0014] By using the system provided by the disclosure, forming a single first loop antenna on the printed circuit board on the basic function module as a first near-field communication antenna unit, forming a single second loop antenna on the printed circuit board on each extended function module as corresponding at least one second near-field communication antenna unit, and keeping the printed circuit boards on the basic function module and the extended function modules on a plane, the near-field communication effect between two adjacent function modules can effectively be improved, and in addition interference caused by other function modules during communication between two adjacent extended function modules can be reduced.

[0015] By using the system provided by the disclosure, using a single near-field communication antenna unit formed on one side of the printed circuit board on the basic function module as a first near-field communication antenna unit, and using two near-field communication antenna units formed on two sides of the printed circuit board on the extended function module as at least one second near-field communication antenna unit, the near-field communication effect between two adjacent function modules can effectively be improved, and in addition interference caused by other function modules during communication between two adjacent extended function modules can be reduced.

[0016] By using the system provided by the disclosure and installing a communication destination determination unit for determining the destination function module of downstream communication on each extended function module, cascades between the basic function module and at least one extended function module can be implemented for communication, direct mutual communication is allowed only between adjacent function modules of the cascaded function modules, and thus interference caused by other function modules during communication between two adjacent extended function modules can be reduced.

Brief Description of the Drawings

[0017] The essence and advantages of the disclosure may be further understood by reference to the drawings. In the drawings, similar components or characteristics may have the same reference numerals.

Fig. 1 is a schematic diagram of communication between the basic function module and extended function modules in a prior communication system;

Fig. 2 is a schematic diagram of the system for communication according to a first embodiment of the

disclosure;

Fig. 3 is a schematic diagram of one implementation example of the system for communication according to the first embodiment of the disclosure;

Fig. 4 is a schematic diagram of an example of near-field communication antenna units formed on a function module according to the first embodiment of the disclosure;

Fig. 5 is a schematic diagram of the system for communication according to a second embodiment of the disclosure;

Fig. 6A is a schematic diagram of one implementation example of the first near-field communication antenna unit in the system for communication according to the second embodiment of the disclosure;

Fig. 6B is a schematic diagram of one implementation example of a second near-field communication antenna unit in the system for communication according to the second embodiment of the disclosure;

Fig. 7A is a schematic diagram of another implementation example of the first near-field communication antenna unit in the system for communication according to the second embodiment of the disclosure;

Fig. 7B is a schematic diagram of another implementation example of a second near-field communication antenna unit in the system for communication according to the second embodiment of the disclosure;

Fig. 8A is a schematic diagram of a further implementation example of a first near-field communication antenna unit in the system for communication according to the second embodiment of the disclosure;

Fig. 8B is a schematic diagram of a further implementation example of a second near-field communication antenna unit in the system for communication according to the second embodiment of the disclosure.

Description of reference numerals in the drawings

[0018]

100: Communication system

110: Basic function module

120-1, 120-2, ..., 120-N: Extended function module

130-1, 130-2, ..., 130-N: SPI

200: Communication system

210: Basic function module

220-1, 220-2, 220-3: Extended function module

230: First near-field communication transceiver unit

240-1, 240-2, 240-3: Second near-field communication transceiver unit

250: First near-field communication antenna unit

260-1, 260-2, 260-3: Second near-field communication antenna unit

270-1, 270-2, 270-3: Communication destination determination unit

280: Main printed circuit board

200': Communication system

250': First near-field communication antenna unit

260'-1-L, 260'-2-L, 260'-3-L: Second near-field communication antenna unit on the left of the first extended function module to third extended function module

260'-1-R, 260'-2-R, 260'-3-R: Second near-field communication antenna unit on the right of the first extended function module to third extended function module

251', 261-1-L, 261-1-R: Mutual-inductance element

252, 252': First loop antenna

262, 262-1, 262'-1-R: Second loop antenna

253': First printed circuit board

263'-1-R: Second printed circuit board

254': First flexible printed circuit board

255': First frame board

256': First connecting mechanism

264'-1-R: Second flexible printed circuit board

265': Second frame board

266': Second connecting mechanism

Detailed Description of the Invention

[0019] Now, the subject described in this document is discussed by reference to exemplary implementation modes. It should be understood that the discussions about these implementation modes are only intended to let those skilled in the art have a better understanding so as to realize the subject described in this document, but are not intended to restrict the scope of protection, applicability, or examples described in the claims. Changes can be made to the functions and arrangements of the discussed elements, without departing from the scope of protection of the disclosure. Various processes or components can be omitted, replaced, or added in different examples, as required. For example, the described method can be executed in a sequence different from what is described, and steps can be added, omitted or combined. In addition, the characteristics described in relation to some examples can also be combined in other examples.

[0020] As used in this document, the term "comprise" and its variants are open terms and mean "include but are not limited to." The term "based on" means "at least partially based on." The term "one embodiment" means "at least one embodiment." The term "another embodiment" means "at least one other embodiment." The terms "first" and "second" may refer to different or identical objects. Other definitions, explicit or implicit, may be included below. Unless otherwise specified in the context, the definition of a term is consistent throughout the description.

[0021] Fig. 2 is a schematic diagram of the system 200 for communication (referred to as communication system 200 hereinafter) according to a first embodiment of the disclosure.

[0022] As shown in Fig. 2, the communication system 200 comprises a basic function module 210 and at least one extended function module. Three extended function modules 220-1, 220-2 and 220-3 are shown in the example in Fig. 2. The basic function module 210 is used to implement the basic functions of the communication system 200, and the basic function module is, according to the invention, the main control module of a programmable logic controller (PLC). Extended function modules are used to implement extended functions of the communication system 200. Extended function modules are, according the invention, extended input/output (I/O) modules of a PLC and the purpose of extended function modules is to extend I/O points of the basic function module. In the disclosure, the communication system is used to transmit I/O data of a PLC. PLC, according to the invention. Communication between the basic function module and an extended function module mainly enables the basic function module to implement the setting of the output port of the extended function module and the collection of the state of the input port of the extended function module. Data sent from the basic function module may be addressed to a specific extended function module or addressing of the data may be implemented in shared

data structure mode. On the contrary, data sent back from an extended function module may be data sent from a specific extended function module and containing the address of the extended function module, or may also be data returned to the basic function module after a specific position is filled in the shared data structure of the extended function modules.

[0023] The basic function module 210 comprises a first near-field communication transceiver unit 230 and a first near-field communication antenna unit 250. The first near-field communication transceiver unit 230 is electrically connected with the first near-field communication antenna unit 250. For example, the first near-field communication transceiver unit 230 and the first near-field communication antenna unit 250 can implement electrical communication in electrical connection mode through wiring on the printed circuit board. The first near-field communication transceiver unit 230 is used to process wireless communication signals received by the first near-field communication antenna unit 250 to convert them to signals that the basic function module 210 can identify and process, or to convert data to be sent in the basic function module 210 to wireless communication signals suitable for the first near-field communication antenna unit 250 to send and then send them out through the first near-field communication antenna unit 250. In the disclosure, the first near-field communication transceiver unit 230 can be, for example, any suitable communication transceiver. The first near-field communication antenna unit 250 is used to send or receive wireless communication signals in near-field communication mode. The first near-field communication antenna unit 250 comprises a first loop antenna 252 printed on a printed circuit board. Here, the printed circuit board may be the main printed circuit board of the basic function module 210, or may also be a printed circuit board other than the main printed circuit board of the basic function module 210.

[0024] Each extended function module comprises at least one second near-field communication transceiver unit and at least one second near-field communication antenna unit. Similarly, the at least one second near-field communication transceiver unit is electrically connected with the corresponding second near-field communication antenna unit. For example, the second near-field communication transceiver unit and the second near-field communication antenna unit can implement electrical communication in electrical connection mode through wiring on the printed circuit board. In the example shown in Fig. 2, each extended function module has a single second near-field communication antenna unit. For example, the first extended function module 220-1 has a second near-field communication antenna unit 260-1, the second extended function module 220-2 has a second near-field communication antenna unit 260-2 and the third extended function module 220-3 has a second near-field communication antenna unit 260-3. The second near-field communication antenna unit comprises a sec-

ond loop antenna printed on a printed circuit board. Here, the printed circuit board may be the main printed circuit board of an extended function module, or may also be a printed circuit board other than the main printed circuit board of an extended function module.

[0025] Fig. 3 is a schematic diagram of one implementation example of the system for communication according to the first embodiment of the disclosure. Only the basic function module 210 and the first extended function module 220-1 are shown in the communication system in Fig. 3.

[0026] In the communication system shown in Fig. 3, the first near-field communication antenna unit 250 is a single first loop antenna 252 formed on the main printed circuit board 280 of the basic function module 210. At least one second near-field communication antenna unit is a single second loop antenna formed on the main printed circuit board of a corresponding extended function module, for example, a single second loop antenna 262-1 formed on the main printed circuit board of the first extended function module 220-1. In addition, the basic function module 210 and the extended function modules are so arranged that the communication distance between two near-field communication antenna units on two adjacent function modules is within the set near-field communication distance, the main printed circuit boards on the basic function module 210 and the extended function modules are parallel to each other, and the height difference between the planes where the main printed circuit boards on two adjacent modules are located is less than a preset threshold. In this document, the preset threshold is determined based on the set near-field communication distance. In one example of the disclosure, the main printed circuit boards may be located on a plane, for example.

[0027] In addition, alternatively, each of the first loop antenna 252 and the second loop antenna 262 may be formed by performing loop wiring along two side edges of a corresponding printed circuit board to form a wiring loop, as shown in Figs. 3 and 4.

[0028] In addition, in an example of the embodiment, the first loop antenna 252 and the second loop antenna 262 are configured to have the same/a similar loop shape. In addition, the first loop antenna 252 and the second loop antenna 262 may be configured to be parallel to each other.

[0029] Fig. 4 is a schematic diagram of an example of near-field communication antenna units formed on a function module according to the first embodiment of the disclosure. As shown in Fig. 4, the size of the formed loop antennas is 35.5 cm × 20 cm. In other examples of the disclosure, the size of the loop antennas may also be other suitable sizes. The sizes and/or shapes of the first loop antenna 252 and the second loop antenna 262 may be determined according to the set near-field communication distance. In one example of the disclosure, the set near-field communication distance may be set to 1 cm to 2 cm. In one example of the disclosure, the first loop antenna 252 and the second loop antenna 262 may

be formed by use of copper wiring on the printed circuit boards. In other examples of the disclosure, the first loop antenna 252 and the second loop antenna 262 may be formed by use of wiring of other conductive materials on the printed circuit boards.

[0030] In another example of the disclosure, the communication system may comprise at least two extended function modules. According to the embodiments of the disclosure, the basic function module 210 may be cascaded with the extended function modules, and near-field communication mode is adopted between function modules to implement cascade communication, that is to say, the basic function module 210 communicates with the first extended function module 220-1, the first extended function module 220-1 communicates with the second extended function module 220-2, and the second extended function module 220-2 communicates with the third extended function module 220-3. In this way, data of the basic function module 210 can be sent to the first extended function module 220-1, the second extended function module 220-2 and the third extended function module 220-3 in turn in near-field communication mode. Similarly, data of the third extended function module 220-3 may also be sent to the second extended function module 220-2, the first extended function module 220-1 and the basic function module 210 in turn in near-field communication mode.

[0031] Accordingly, each of the at least two extended function modules comprises a communication destination determination unit for determining the destination function module of downstream communication according to the data source of data to be sent in the extended function module. For example, the first extended function module 220-1 and the second extended function module 220-2 have the communication destination determination unit 270-1 and the communication destination determination unit 270-2, respectively. The communication destination determination unit 270-1 is used to determine the destination function module of downstream communication happening at the first extended function module 220-1 according to the data source of received data in the first extended function module 220-1. For example, when the received data on the first extended function module 220-1 comes from the basic function module 210, the destination function module of downstream communication happening at the first extended function module 220-1 is the second extended function module 220-2, that is to say, data received from the basic function module 210 is forwarded to the second extended function module 220-2. When the received data on the first extended function module 220-1 comes from the second extended function module 220-2, the destination function module of downstream communication happening at the first extended function module 220-1 is the basic function module 210, that is to say, data received from the second extended function module 220-2 is forwarded to the basic function module 210. Similarly, the communication destination determination unit 270-2 is used to determine the

destination function module of downstream communication happening at the second extended function module 220-2 according to the data source of received data in the second extended function module 220-2.

[0032] In one example of the disclosure, the communication destination determination unit may be any mechanism having a corresponding capability, or any processor, field programmable gate array (FPGA), integrated circuit or single-chip microcomputer having a corresponding capability.

[0033] In one example of the disclosure, the data source of data to be sent may be identified by use of identification information, and in addition the identification information is sent together with the data to be sent to a corresponding extended function module. Thus, the communication destination determination unit may determine the data source of data to be sent according to the received identification information.

[0034] In one example of the disclosure, the first near-field communication antenna unit 250 and the at least one second near-field communication antenna units 260-1, 260-2, and 260-3 may be configured to be arranged along a line, and the distance between the near-field communication antenna units on two adjacent function modules is within the set near-field communication distance. In one example of the disclosure, the set near-field communication distance may be set to 1 cm to 2 cm. In another example of the disclosure, the set communication distance may be set to other proper distances according to the specific situation.

[0035] Fig. 5 is a schematic diagram of the system for communication (referred to as communication system 200' hereinafter) according to a second embodiment of the disclosure. The embodiment shown in Fig. 5 is an improvement of the embodiment shown in Fig. 2, and the difference is that the extended function modules in Fig. 5 each have two near-field communication antenna units, instead of a single near-field communication antenna unit. The other components shown in Fig. 5 are the same as the other components shown in Fig. 2, and they will not be described here again.

[0036] In the example shown in Fig. 5, each extended function module has two near-field communication antenna units. For example, the first extended function module 220-1 has two second near-field communication antenna units 260'-1-L and 260'-1-R, the second extended function module 220-2 has two second near-field communication antenna units 260'-2-L and 260'-2-R, and the third extended function module 220-3 has two second near-field communication antenna units 260'-3-L and 260'-3-R. The two near-field communication antenna units on each extended function module are respectively located at the side edges, namely left edge and right edge, of the printed circuit board on the extended function module. In the embodiment, the basic function module has one near-field communication antenna unit and the near-field communication antenna unit is located at one side edge of the printed circuit board on the basic function

module.

[0037] When the system works, the near-field communication antenna unit on each side of an extended function module communicates with a corresponding near-field communication antenna unit on an adjacent function module. For example, when the basic function module 210 and extended function modules are placed in turn from left to right, the first near-field communication antenna unit 250' on the basic function module 210 is located on the right side of the main printed circuit board on the basic function module 210. The first near-field communication antenna unit 250' on the basic function module 210 communicates with the second near-field communication antenna unit 260'-1-L on the left side of the first extended function module 220-1 and is used to send data from the basic function module 210 to the second near-field communication antenna unit 260'-1-L or receive data from the second near-field communication antenna unit 260'-1-L. Accordingly, the second near-field communication antenna unit 260'-1-R on the right side of the first extended function module 220-1 communicates with the second near-field communication antenna unit 260'-2-L on the left side of the second extended function module 220-2 and is used to send data from the first extended function module 220-1 to the second near-field communication antenna unit 260'-2-L or receive data from the second near-field communication antenna unit 260'-2-L. Alike, the near-field communication antenna units on the other extended function modules communicate with corresponding near-field communication antenna units in a similar way. In the embodiment, alike, the first near-field communication antenna unit 250' and the at least one second near-field communication antenna units 260'-1, 260'-2, and 260'-3 are configured to be arranged along a line, and the distance between the near-field communication antenna units on two adjacent function modules is within the set near-field communication distance.

[0038] Fig. 6A is a schematic diagram of one implementation example of a first near-field communication antenna unit 250' in the communication system 200' according to the second embodiment of the disclosure. Fig. 6B is a schematic diagram of one implementation example of a second near-field communication antenna unit 260'-1 in the communication system according to the second embodiment of the disclosure. As shown in Figs. 6A and 6B, the first near-field communication antenna unit 250' may be formed by use of one mutual-inductance element 251', and the second near-field communication antenna units 260' may be formed by use of two mutual-inductance elements 261'. Alternatively, in one example, the mutual-inductance element may be at least one of the following: inductor or inductance coil.

[0039] Fig. 7A is a schematic diagram of another implementation example of the first near-field communication antenna unit 250' in the communication system 200' according to the second embodiment of the disclosure, and Fig. 7B is a schematic diagram of another implemen-

tation example of the second near-field communication antenna unit 260'-1 in the communication system 200' according to the second embodiment of the disclosure.

[0040] As shown in Figs. 7A and 7B, the first near-field communication antenna unit 250' comprises a first printed circuit board 253' printed with a first loop antenna 252' thereon and the first printed circuit board 253' is vertically fixed at one side edge of the main printed circuit board on the basic function module 210. The second near-field communication antenna unit 260'-1 comprises two second printed circuit boards 263' printed with a second loop antenna 262' thereon and the two second printed circuit boards 263' are vertically fixed at two side edges of the main printed circuit board on the extended function module 220-1. In the example shown in Figs. 7A and 7B, the first near-field communication antenna unit 250' is electrically connected with the first near-field communication transceiver unit 230. For example, an electrical communication interface electrically connected with the first near-field communication antenna unit 250' is provided at the edge of the first printed circuit board 253' and an electrical communication interface electrically connected with the first near-field communication transceiver unit 230 is also provided at the corresponding side edge of the main printed circuit board of the basic function module 210. When the first printed circuit board 253' is vertically fixed at one side edge of the main printed circuit board of the basic function module 210, the two electrical communication interfaces are coupled to implement electrical communication between two printed circuit boards. Alike, an electrical connection between the second near-field communication antenna unit and the second near-field communication transceiver unit is implemented in a similar way to implement electrical communication.

[0041] Alike, in the example shown in Figs. 7A and 7B, each of the first loop antenna 252' and the second loop antenna 262' may be formed by performing loop wiring along two side edges of a corresponding printed circuit board to form a wiring loop. In addition, the first loop antenna 252' and the second loop antenna 262' may be configured to have the same/a similar loop shape. In addition, the first loop antenna and the second loop antenna may be configured to be parallel to each other. The size of the formed loop antenna may be 35.5 cm × 20 cm. In other examples of the disclosure, the size of the loop antennas may also be other suitable sizes. The sizes and/or shapes of the first loop antenna and the second loop antenna may be determined according to the set near-field communication distance. In one example of the disclosure, the first loop antenna and the second loop antenna may be formed by use of copper wiring on the printed circuit boards. In other examples of the disclosure, the first loop antenna and the second loop antenna may be formed by use of wiring of other conductive materials on the printed circuit boards.

[0042] Fig. 8A is a schematic diagram of a further implementation example of the first near-field communication antenna unit 250' in the communication system 200'

according to the second embodiment of the disclosure, and Fig. 8B is a schematic diagram of a further implementation example of the second near-field communication antenna unit 260'-1 in the communication system 200' according to the second embodiment of the disclosure.

[0043] As shown in Figs. 8A and 8B, the first near-field communication antenna unit 250' may comprise a first frame board 255' with a first flexible printed circuit board 254' attached on one side and two first connecting mechanisms 256', the first frame board 255' is vertically fixed by use of the two first connecting mechanisms 256' at two side edges of the main printed circuit board of the basic function module 210, and a first loop antenna 252' is printed on the first flexible printed circuit board 254'. The at least one second near-field communication antenna unit may comprise a second frame board 265' with a second flexible printed circuit board 264' respectively attached on two opposite side surfaces and two second connecting mechanisms 266', and the second frame board 265' is vertically fixed by use of the two second connecting mechanisms 266' at two side edges of the main printed circuit board of a corresponding extended function module. Alike, a second loop antenna 262' is printed on the second flexible printed circuit board 264'. In the example shown in Figs. 8A and 8B, an electrical connection and electrical communication between the first near-field communication antenna unit 250' and the first near-field communication transceiver unit 230 may be implemented in the way shown in Figs. 7A and 7B. Alike, an electrical connection and electrical communication between the second near-field communication antenna unit and the second near-field communication transceiver unit may also be implemented in the way shown in Figs. 7A and 7B.

[0044] In the example, the first frame board 255' and the second frame board 265' are configured to respectively match the shapes of the casings of the basic function module 210 and a corresponding extended function module 220, and are fixed on the casings.

[0045] Alike, in the example shown in Figs. 8A and 8B, each of the first loop antenna 252' and the second loop antenna 262' may be formed by performing loop wiring along two side edges of a corresponding printed circuit board to form a wiring loop. In addition, the first loop antenna 252' and the second loop antenna 262' may be configured to have the same/a similar loop shape. In addition, the first loop antenna and the second loop antenna may be configured to be parallel to each other. The size of the formed loop antenna may be 35.5 cm × 20 cm. In other examples of the disclosure, the size of the loop antennas may also be other suitable sizes. The sizes and/or shapes of the first loop antenna 252' and the second loop antenna 262' may be determined according to the set near-field communication distance. In one example of the disclosure, the first loop antenna 252' and the second loop antenna 262' may be formed by use of copper wiring on the printed circuit boards. In other examples

of the disclosure, the first loop antenna 252' and the second loop antenna 262' may be formed by use of wiring of other conductive materials on the printed circuit boards.

[0046] In addition, when two near-field communication antenna units and a single near-field communication transceiver unit exist on an extended function module, the near-field communication transceiver unit may be configured to have two wiring interfaces, and each wiring interface is respectively electrically connected with a near-field communication antenna unit. Or, a switch may be placed between the near-field communication transceiver unit and the two near-field communication antenna units, and thus an electrical connection and electrical communication between the near-field communication transceiver unit and a corresponding near-field communication antenna unit is implemented based on the determination result of the communication destination determination unit on the extended function module.

[0047] In addition, other variations can be made to the embodiment shown in Fig. 5. For example, each extended function module may have two near-field communication transceiver units and each near-field communication transceiver unit corresponds to a second near-field communication antenna unit.

[0048] The embodiments described above in combination with the drawings are only exemplary embodiments, but do not represent all embodiments that can be realized or fall within the scope of protection of the claims. The term "exemplary" used in the whole description means "used as an example, instance or illustration", but does not mean "preferable" to or "advantageous" over other embodiments. For the purpose of providing an understanding of the described techniques, the embodiments cover specific details. However, these techniques may be carried out without these specific details. In some embodiments, well-known structures and devices are shown in the form of a block diagram to avoid the difficulty in understanding the concepts in the described embodiments. The invention is defined by the appended claims.

Claims

1. A system (200, 200') for near-field communication between a basic function module and at least one extended function module, comprising:

the basic function module (210),
the at least one extended function module (220-1, 220-2, 220-3),
a first near-field communication transceiver unit (230) and a first near-field communication antenna unit (250, 250') located on the basic function module (210), and
at least one second near-field communication transceiver unit (240-1, 240-2, 240-3) and
at least one second near-field communication

antenna unit (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3) located on each extended function module of the at least one extended function module (220-1, 220-2, 220-3),

characterized in that

the first near-field communication antenna unit (250, 250') and the at least one second near-field communication antenna unit (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3) respectively comprise a first loop antenna (252, 252') and a second loop antenna (262, 262') printed on a printed circuit board, and

the basic function module (210) is a main control module of a programmable logic controller, PLC, and

the at least one extended function module (220-1, 220-2, 220-3) is an extended input/output (I/O) module of the PLC that is configured to extend I/O points of the basic function module (210) to transmit I/O data of the PCL through near-field communication.

2. The system (200, 200') as claimed in claim 1, **characterized in that** each of the first loop antenna (252, 252') and the second loop antenna (262, 262') is formed by performing loop wiring along two side edges of a corresponding printed circuit board to form a wiring loop.

3. The system (200, 200') as claimed in claim 2, **characterized in that** the first loop antenna (252, 252') and the second loop antenna (262, 262') are configured to have the same/a similar loop shape and/or be parallel to each other, or **in that** the sizes and/or shapes of the first loop antenna (252, 252') and the second loop antenna (262, 262') are determined according to a set near-field communication distance.

4. The system (200, 200') as claimed in claim 1, **characterized in that** the first near-field communication antenna unit (250, 250') and the at least one second near-field communication antenna unit are configured to be arranged along a line and the distance between the near-field communication antenna units on two adjacent function modules is within the set near-field communication distance.

5. The system (200) as claimed in any of claims 1 to 4, **characterized in that** the first near-field communication antenna unit (250) comprises a single first loop antenna (252) formed on the main printed circuit board on the basic function module (210), the at least one second near-field communication antenna unit comprises a single second loop antenna (262) formed on the main printed circuit board on a corresponding extended function module, the planes where the main printed circuit boards on the basic function module (210) and the extended function

modules are located are parallel to each other, the height difference between the planes where the main printed circuit boards on two adjacent modules are located is less than a preset threshold, and the preset threshold is determined based on the set near-field communication distance.

6. The system (200') as claimed in any of claims 1 to 4, **characterized in that** the first near-field communication antenna unit (250') comprises a first printed circuit board (253') printed with a first loop antenna (252') thereon and the first printed circuit board (253') is vertically fixed at one side edge of the main printed circuit board on the basic function module (210), the at least one second near-field communication antenna unit comprises two second printed circuit boards printed with a corresponding second loop antenna (262') thereon and the two second printed circuit boards are respectively vertically fixed at two side edges of the main printed circuit board on a corresponding extended function module.

7. The system (200') as claimed in any of claims 1 to 4, **characterized in that** the first near-field communication antenna unit (250') comprises a first frame board (255') with a first flexible printed circuit board (254') attached on one side and two first connecting mechanisms (256'), a first loop antenna (252') is printed on the first flexible printed circuit board (254'), the first frame board (255') is vertically fixed by use of the two first connecting mechanisms (256') at two side edges of the main printed circuit board of the basic function module (210), and the at least one second near-field communication antenna unit comprises a second frame board (265') with a second flexible printed circuit board (264') respectively attached on two opposite side surfaces and two second connecting mechanisms (266'), a second loop antenna (262') is printed on the second flexible printed circuit board (264'), and the second frame board (265') is vertically fixed by use of the two second connecting mechanisms (266') at two side edges of the main printed circuit board of a corresponding extended function module.

8. The system (200, 200') as claimed in claim 1, **characterized in that** the system comprises at least two extended function modules, the basic function module (210) and the extended function modules are cascaded for communication, and each extended function module has a communication destination determination unit, configured to determine the destination function module of downstream communication according to a data source of the data to be sent in the extended function module, wherein direct mutual communication is allowed only between adjacent function modules of the cascaded function modules.

9. The system (200, 200') as claimed in claim 1, **characterized in that** the basic function module (210) is a programmable logic controller module and the extended function modules are programmable logic controller modules.

10. A basic function module (210) for near-field communication with at least one extended function module (220-1, 220-2, 220-3), wherein the at least one extended function module comprises a second near-field communication transceiver unit (240-1, 240-2, 240-3) and a second near-field communication antenna unit (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3), wherein the second near-field communication antenna unit comprises a second loop antenna (262, 262') printed on a printed circuit board, the basic function module comprising:

a first near-field communication transceiver unit (230), and

a first near-field communication antenna unit (250, 250'),

characterized in that

the first near-field communication antenna unit (250, 250') comprises a first loop antenna (252, 252') printed on a printed circuit board, and the basic function module (210) is a main control module of a programmable logic controller, (PLC), that is adapted to transmit input/output (I/O) data of the PCL to the at least one extended function module (220-1, 220-2, 220-3) so that I/O points of the basic function module (210) are extended by the at least one extended function module through near-field communication.

11. The basic function module (210) as claimed in claim 10, **characterized in that** the first loop antenna (252, 252') is formed by performing loop wiring along two side edges of a corresponding printed circuit board to form a wiring loop.

12. The basic function module (210) as claimed in claim 10 or 11, **characterized in that** the first near-field communication antenna unit (250) comprises a single first loop antenna (252) formed on the main printed circuit board on the basic function module (210), or **in that** the first near-field communication antenna unit (250') comprises a first printed circuit board (253') printed with a first loop antenna (252') thereon and the first printed circuit board (253') is vertically fixed at one side edge of the main printed circuit board on the basic function module (210), or **in that** the first near-field communication antenna unit (250') comprises a first frame board (255') with a first flexible printed circuit board (254') attached on one side and two first connecting mechanisms (256'), wherein a first loop antenna (252') is printed on the first flexible printed circuit board (254'), and the first frame

board (255') is vertically fixed by use of the two first connecting mechanisms (256') at two side edges of the main printed circuit board of the basic function module (210), or **in that** the basic function module (210) is a programmable logic controller module.

Patentansprüche

1. System (200, 200') zur Nahfeldkommunikation zwischen einem Grundfunktionsmodul und mindestens einem Zusatzfunktionsmodul, das Folgendes umfasst:

das Grundfunktionsmodul (210), das mindestens eine Zusatzfunktionsmodul (220-1, 220-2, 220-3), eine erste Nahfeldkommunikations-Transceivereinheit (230) und eine erste Nahfeldkommunikations-Antenneneinheit (250, 250'), die sich auf dem Grundfunktionsmodul (210) befinden, und mindestens eine zweite Nahfeldkommunikations-Transceivereinheit (240-1, 240-2, 240-3) und mindestens eine zweite Nahfeldkommunikations-Antenneneinheit (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3), die sich auf jedem Zusatzfunktionsmodul des mindestens einen Zusatzfunktionsmoduls (220-1, 220-2, 220-3) befindet,

dadurch gekennzeichnet, dass

die erste Nahfeldkommunikations-Antenneneinheit (250, 250') und die mindestens eine zweite Nahfeldkommunikations-Antenneneinheit (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3) jeweils eine erste Schleifenantenne (252, 252') und eine zweite Schleifenantenne (262, 262') umfassen, die auf einer Leiterplatte gedruckt sind, und

das Grundfunktionsmodul (210) ein Hauptsteuermodul einer speicherprogrammierbaren Steuerung, SPS, ist, und

das mindestens eine Zusatzfunktionsmodul (220-1, 220-2, 220-3) ein erweitertes Eingangs-/Ausgangsmodul (E/A) der SPS ist, das dafür ausgebildet ist, E/A-Punkte des Grundfunktionsmoduls (210) zu erweitern, um E/A-Daten der SPS durch Nahfeldkommunikation zu übertragen.

2. System (200, 200') nach Anspruch 1, **dadurch gekennzeichnet, dass** sowohl die erste Schleifenantenne (252, 252') als auch die zweite Schleifenantenne (262, 262') durch Schleifenverdrahtung entlang zweier Seitenkanten einer entsprechenden Leiterplatte gebildet wird, um eine Verdrahtungsschleife zu bilden.

3. System (200, 200') nach Anspruch 2, **dadurch gekennzeichnet, dass** die erste Schleifenantenne (252, 252') und die zweite Schleifenantenne (262, 262') dafür ausgebildet sind, die gleiche/ähnliche Schleifenform zu haben und/oder parallel zueinander zu sein, oder dass die Größen und/oder Formen der ersten Schleifenantenne (252, 252') und der zweiten Schleifenantenne (262, 262') gemäß einem festgelegten Nahfeldkommunikationsabstand bestimmt sind. 5
4. System (200, 200') nach Anspruch 1, **dadurch gekennzeichnet, dass** die erste Nahfeldkommunikations-Antenneneinheit (250, 250') und die mindestens eine zweite Nahfeldkommunikations-Antenneneinheit dafür ausgebildet sind, entlang einer Linie angeordnet zu sein, und der Abstand zwischen den Nahfeldkommunikations-Antenneneinheiten auf zwei benachbarten Funktionsmodulen innerhalb des eingestellten Nahfeldkommunikationsabstands liegt. 10
5. System (200) nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die erste Nahfeldkommunikations-Antenneneinheit (250) eine einzelne erste Rahmenantenne (252) umfasst, die auf der Hauptleiterplatte auf dem Grundfunktionsmodul (210) gebildet ist, die mindestens eine zweite Nahfeldkommunikations-Antenneneinheit eine einzelne zweite Rahmenantenne (262) umfasst, die auf der Hauptleiterplatte auf einem entsprechenden Zusatzfunktionsmodul gebildet ist, die Ebenen, in denen sich die Hauptleiterplatten auf dem Grundfunktionsmodul (210) und den Zusatzfunktionsmodulen befinden, parallel zueinander sind, der Höhenunterschied zwischen den Ebenen, in denen sich die Hauptleiterplatten auf zwei benachbarten Modulen befinden, kleiner als ein voreingestellter Schwellenwert ist, und der voreingestellte Schwellenwert auf der Grundlage des eingestellten Nahfeldkommunikationsabstands bestimmt wird. 15
6. System (200') nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die erste Nahfeldkommunikations-Antenneneinheit (250') eine erste Leiterplatte (253') umfasst, die mit einer ersten Schleifenantenne (252') bedruckt ist, und die erste Leiterplatte (253') vertikal an einer Seitenkante der Hauptleiterplatte auf dem Grundfunktionsmodul (210) befestigt ist, die mindestens eine zweite Nahfeldkommunikations-Antenneneinheit zwei zweite Leiterplatten umfasst, die mit einer entsprechenden zweiten Schleifenantenne (262') bedruckt sind, und die beiden zweiten Leiterplatten jeweils vertikal an zwei Seitenkanten der Hauptleiterplatte auf einem entsprechenden Zusatzfunktionsmodul befestigt sind. 20
7. System (200') nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die erste Nahfeldkommunikations-Antenneneinheit (250') eine erste Rahmenplatine (255') mit einer auf einer Seite angebrachten ersten flexiblen Leiterplatte (254') und zwei ersten Verbindungsmechanismen (256') umfasst, eine erste Rahmenantenne (252') auf der ersten flexiblen Leiterplatte (254') aufgedruckt ist, die erste Rahmenplatine (255') unter Verwendung der beiden ersten Verbindungsmechanismen (256') an zwei Seitenkanten der Hauptleiterplatte des Grundfunktionsmoduls (210) vertikal befestigt ist, und die mindestens eine zweite Nahfeldkommunikations-Antenneneinheit eine zweite Rahmenplatine (265') mit einer zweiten flexiblen Leiterplatte (264'), die jeweils an zwei gegenüberliegenden Seitenflächen angebracht ist, und zwei zweiten Verbindungsmechanismen (266') umfasst, eine zweite Schleifenantenne (262') auf die zweite flexible Leiterplatte (264') gedruckt ist und die zweite Rahmenplatine (265') unter Verwendung der beiden zweiten Verbindungsmechanismen (266') an zwei Seitenkanten der Hauptleiterplatte eines entsprechenden Zusatzfunktionsmoduls vertikal befestigt ist. 25
8. System (200, 200') nach Anspruch 1, **dadurch gekennzeichnet, dass** das System mindestens zwei Zusatzfunktionsmodule umfasst, wobei das Grundfunktionsmodul (210) und die Zusatzfunktionsmodule für die Kommunikation kaskadiert sind und jedes Zusatzfunktionsmodul eine Kommunikationszielbestimmungseinheit aufweist, die ausgebildet ist, um das Zielfunktionsmodul der nachgeschalteten Kommunikation gemäß einer Datenquelle der im Zusatzfunktionsmodul zu sendenden Daten zu bestimmen, wobei eine direkte gegenseitige Kommunikation nur zwischen benachbarten Funktionsmodulen der kaskadierten Funktionsmodule zulässig ist. 30
9. System (200, 200') nach Anspruch 1, **dadurch gekennzeichnet, dass** das Grundfunktionsmodul (210) ein speicherprogrammierbares Steuerungsmodul ist und die Zusatzfunktionsmodule speicherprogrammierbare Steuerungsmodule sind. 35
10. Grundfunktionsmodul (210) für Nahfeldkommunikation mit mindestens einem Zusatzfunktionsmodul (220-1, 220-2, 220-3), wobei das mindestens eine Zusatzfunktionsmodul eine zweite Nahfeldkommunikations-Transceiverereinheit (240-1, 240-2, 240-3) und eine zweite Nahfeldkommunikations-Antenneneinheit (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3) umfasst, wobei die zweite Nahfeldkommunikations-Antenneneinheit eine zweite Schleifenantenne (262, 262) umfasst, die auf eine Leiterplatte gedruckt ist, wobei das Grundfunktionsmodul Folgendes umfasst: 40

eine erste Nahfeldkommunikations-Transceiver-einheit (230), und eine erste Nahfeldkommunikations-Antenneneinheit (250, 250'), **dadurch gekennzeichnet, dass**

die erste Nahfeldkommunikations-Antenneneinheit (250, 250') eine erste Schleifenantenne (252, 252') umfasst, die auf eine Leiterplatte gedruckt ist, und

das Grundfunktionsmodul (210) ein Hauptsteuermodul einer speicherprogrammierbaren Steuerung (SPS) ist, das so beschaffen ist, dass es Eingabe-/Ausgabe (E/A)-Daten der SPS an das mindestens eine Zusatzfunktionsmodul (220-1, 220-2, 220-3) überträgt, so dass E/A-Punkte des Grundfunktionsmoduls (210) durch das mindestens eine Zusatzfunktionsmodul über Nahfeldkommunikation erweitert werden.

11. Grundfunktionsmodul (210) nach Anspruch 10, **dadurch gekennzeichnet, dass** die erste Schleifenantenne (252, 252') durch Ausführen einer Schleifenverdrahtung entlang zweier Seitenkanten einer entsprechenden Leiterplatte gebildet wird, um eine Verdrahtungsschleife zu bilden.

12. Grundfunktionsmodul (210) nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** die erste Nahfeldkommunikations-Antenneneinheit (250) eine einzelne erste Schleifenantenne (252) umfasst, die auf der Hauptleiterplatte auf dem Grundfunktionsmodul (210) gebildet ist, oder dass die erste Nahfeldkommunikations-Antenneneinheit (250') eine erste gedruckte Leiterplatte (253') umfasst, die mit einer ersten Schleifenantenne (252') darauf bedruckt ist, und die erste gedruckte Leiterplatte (253') vertikal an einem Seitenrand der Hauptleiterplatte auf dem Grundfunktionsmodul (210) befestigt ist, oder dass die erste Nahfeldkommunikations-Antenneneinheit (250') eine erste Rahmenplatine (255') mit einer einseitig angebrachten ersten flexiblen Leiterplatte (254') und zwei ersten Verbindungsmechanismen (256') umfasst, wobei auf der ersten flexiblen Leiterplatte (254') eine erste Rahmenantenne (252') aufgedruckt ist, und die erste Rahmenplatine (255') unter Verwendung der beiden ersten Verbindungsmechanismen (256') an zwei Seitenkanten der Hauptleiterplatte des Grundfunktionsmoduls (210) vertikal befestigt ist, oder dass das Grundfunktionsmodul (210) ein speicherprogrammierbares Steuermodul ist.

Revendications

1. Système (200, 200') pour une communication en champ proche entre un module de fonction basique et au moins un module de fonction étendue, comprenant :

le module de fonction basique (210),

l'au moins un module de fonction étendue (220-1, 220-2, 220-3), une première unité émettrice-réceptrice de communication en champ proche (230) et une première unité d'antenne de communication en champ proche (250, 250') située sur le module de fonction basique (210), et

au moins une deuxième unité émettrice-réceptrice de communication en champ proche (240-1, 240-2, 240-3), et

au moins une deuxième unité d'antenne de communication en champ proche (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3) située sur chaque module de fonction étendue de l'au moins un module de fonction étendue (220-1, 220-2, 220-3),

caractérisé en ce que

la première unité d'antenne de communication en champ proche (250, 250') et l'au moins une deuxième unité d'antenne de communication en champ proche (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3) comprennent respectivement une première antenne cadre (252, 252') et une deuxième antenne cadre (262, 262') imprimées sur une carte à circuits imprimés, et

le module de fonction basique (210) est un module de commande principal d'un contrôleur logique programmable, PLC, et

l'au moins un module de fonction étendue (220-1, 220-2, 220-3) est un module d'entrée/sortie étendue (I/O) du PLC qui est configuré pour étendre des points I/O du module de fonction basique (210) pour transmettre des données I/O du PLC par une communication en champ proche.

2. Système (200, 200') selon la revendication 1, **caractérisé en ce que** chacune de la première antenne cadre (252, 252') et de la deuxième antenne cadre (262, 262') est formée par réalisation d'un câblage en boucle le long de deux bords latéraux d'une carte à circuits imprimés correspondante pour former une boucle de câblage.
3. Système (200, 200') selon la revendication 2, **caractérisé en ce que** la première antenne cadre (252, 252') et la deuxième antenne cadre (262, 262') sont configurées de façon à avoir une forme de boucle identique/similaire et/ou à être parallèles entre elles, ou **en ce que** les tailles et/ou formes de la première antenne cadre (252, 252') et de la deuxième antenne cadre (262, 262') sont déterminées en fonction d'une distance de communication en champ proche définie.
4. Système (200, 200') selon la revendication 1, **caractérisé en ce que** la première unité d'antenne de

communication en champ proche (250, 250') et l'au moins une deuxième unité d'antenne de communication en champ proche sont configurées de façon à être disposées en ligne et la distance entre les unités d'antenne de communication en champ proche sur deux modules de fonctions adjacents est inférieure à la distance de communication en champ proche définie.

5. Système (200) selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** la première unité d'antenne de communication en champ proche (250) comprend une seule première antenne cadre (252) formée sur la carte à circuits imprimés principale sur le module de fonction basique (210), l'au moins une deuxième unité d'antenne de communication en champ proche comprend une seule deuxième antenne cadre (262) formée sur la carte à circuits imprimés principale sur un module de fonction étendue correspondant, les plans dans lesquels se trouvent les cartes à circuits imprimés principales sur le module de fonction basique (210) et les modules de fonction étendue étant parallèles, la différence de hauteur entre les plans dans lesquels se trouvent les cartes à circuits imprimés principales sur deux modules adjacents étant inférieure à un seuil prédéfini, et le seuil prédéfini étant déterminé en fonction de la distance de communication en champ proche définie.
6. Système (200') selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** la première unité d'antenne de communication en champ proche (250') comprend une première carte à circuits imprimés (253') sur laquelle est imprimée une première antenne cadre (252') et la première carte à circuits imprimés (253') est fixée verticalement sur un bord latéral de la carte à circuits imprimés principale sur le module de fonction basique (210), l'au moins une deuxième unité d'antenne de communication en champ proche comprend deux deuxième cartes à circuits imprimés sur lesquelles est imprimée une deuxième antenne cadre correspondante (262') et les deux deuxième cartes à circuits imprimés sont respectivement fixées verticalement sur deux bords latéraux de la carte à circuits imprimés principale sur un module de fonction étendue correspondant.
7. Système (200') selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** la première unité d'antenne de communication en champ proche (250') comprend une première carte châssis (255') sur une face de laquelle est fixée une première carte à circuits imprimés flexible (254') et deux premiers mécanismes de connexion (256'), une première antenne cadre (252') étant imprimée sur la première carte à circuits imprimés flexible (254'), la première carte châssis (255') étant fixée verticalement à l'aide

des deux premiers mécanismes de connexion (256') au niveau de deux bords latéraux de la carte à circuits imprimés du module de fonction basique (210), et

l'au moins une deuxième unité d'antenne de communication en champ proche comprend une deuxième carte châssis (265') sur deux surfaces latérales opposées de laquelle est fixée une deuxième carte à circuits imprimés flexible (264') et deux deuxième mécanismes de connexion (266'), une deuxième antenne cadre (262') étant imprimée sur la deuxième carte à circuits imprimés flexible (264'), et la deuxième carte châssis (265') étant fixée verticalement à l'aide des deux deuxième mécanismes de connexion (266') au niveau de deux bords latéraux de la carte à circuits imprimés principale d'un module de fonction étendue correspondant.

8. Système (200, 200') selon la revendication 1, **caractérisé en ce que** le système comprend au moins deux module de fonction étendue, le module de fonction basique (210) et les modules de fonction étendue étant agencés en cascade pour la communication, et chaque module de fonction étendue ayant une unité de détermination de destination de communication, configurée pour déterminer le module de fonction de destination de la communication en aval en fonction d'une source de données des données à envoyer dans le module de fonction étendue, une communication mutuelle directe n'étant autorisée qu'entre des modules de fonction adjacents parmi les modules de fonction en cascade.
9. Système (200, 200') selon la revendication 1, **caractérisé en ce que** le module de fonction basique (210) est un module de contrôleur logique programmable et les modules de fonction étendue sont des modules de contrôleur logique programmable.
10. Module de fonction basique (210) pour une communication en champ proche avec au moins un module de fonction étendue (220-1, 220-2, 220-3), l'au moins un module de fonction étendue comprenant une deuxième unité émettrice-réceptrice de communication en champ proche (240-1, 240-2, 240-3) et une deuxième unité d'antenne de communication en champ proche (260-1, 260'-1, 260-2, 260'-2, 260-3, 260'-3), la deuxième unité d'antenne de communication en champ proche comprenant une deuxième antenne cadre (262, 262) imprimée sur une carte à circuits imprimés, le module de fonction basique comprenant :

une première unité émettrice-réceptrice de communication en champ proche (230), et
une première unité d'antenne de communication en champ proche (250, 250'),
caractérisé en ce que

la première unité d'antenne de communication en champ proche (250, 250') comprend une première antenne cadre (252, 252') imprimée sur une carte à circuits imprimés, et

le module de fonction basique (210) est un module de commande principal d'un contrôleur logique programmable, (PLC), qui est conçu pour transmettre des données d'entrée/sortie (I/O) du PLC vers l'au moins un module de fonction étendue (220-1, 220-2, 220-3) de telle sorte que des points I/O du module de fonction basique (210) soient étendus par l'au moins un module de fonction étendue par une communication en champ proche.

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11. Module de fonction basique (210) selon la revendication 10, **caractérisé en ce que** la première antenne cadre (252, 252') est formée par réalisation d'un câblage en boucle le long de deux bords latéraux d'une carte à circuits imprimés correspondante pour former une boucle de câblage.

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12. Module de fonction basique (210) selon la revendication 10 ou 11, **caractérisé en ce que** la première unité d'antenne de communication en champ proche (250) comprend une seule première antenne cadre (252) formée sur la carte à circuits imprimés principale sur le module de fonction basique (210), ou **en ce que** la première unité d'antenne de communication en champ proche (250') comprend une première carte à circuits imprimés (253') sur laquelle est imprimée une première antenne cadre (252') et la première carte à circuits imprimés (253') est fixée verticalement au niveau d'un bord latéral de la carte à circuits imprimés principale sur le module de fonction basique (210), ou **en ce que** la première unité d'antenne de communication en champ proche (250') comprend une première carte châssis (255') sur une face de laquelle est fixée une première carte à circuits imprimés flexible (254') et deux premiers mécanismes de connexion (256'), une première antenne cadre (252') étant imprimée sur la première carte à circuits imprimés flexible (254'), et la première carte châssis (255') étant fixée verticalement à l'aide des deux premiers mécanismes de connexion (256') au niveau de deux bords latéraux de la carte à circuits imprimés principale du module de fonction basique (210), ou **en ce que** le module de fonction basique (210) est un module de contrôleur logique programmable.

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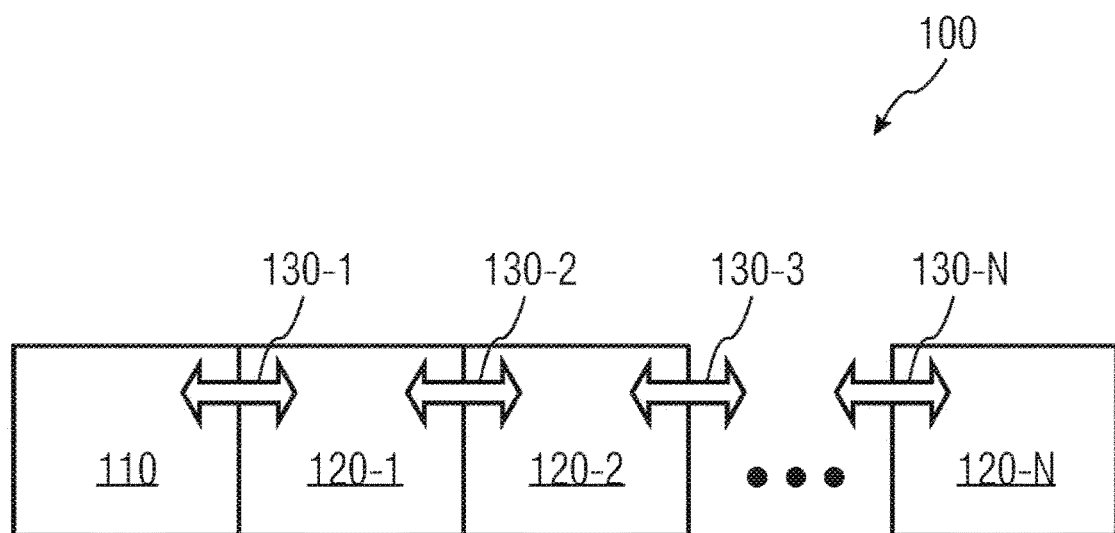


Fig. 1

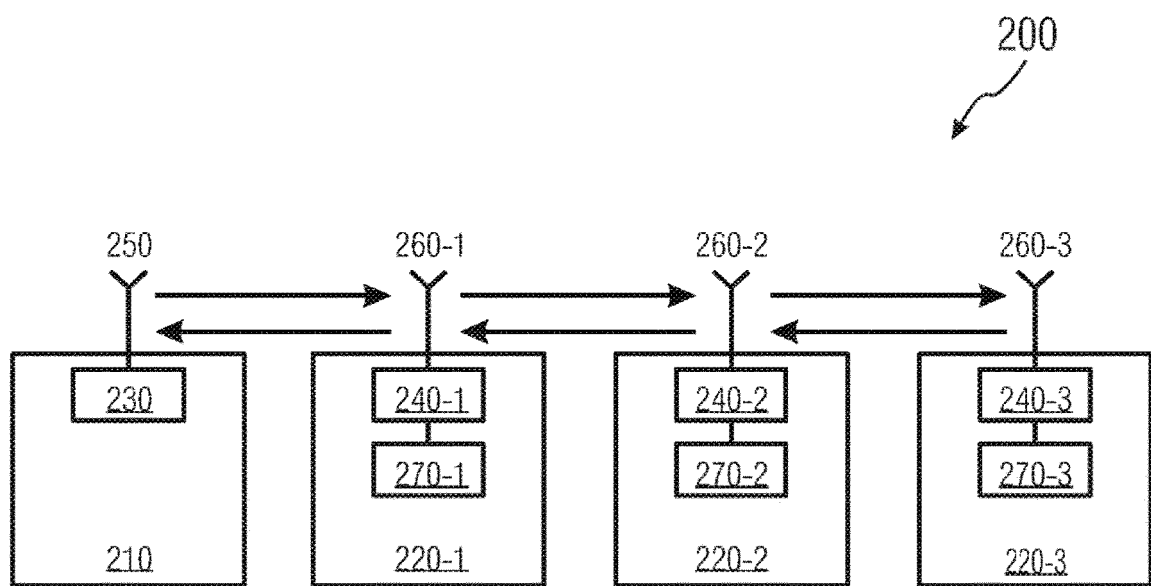


Fig. 2

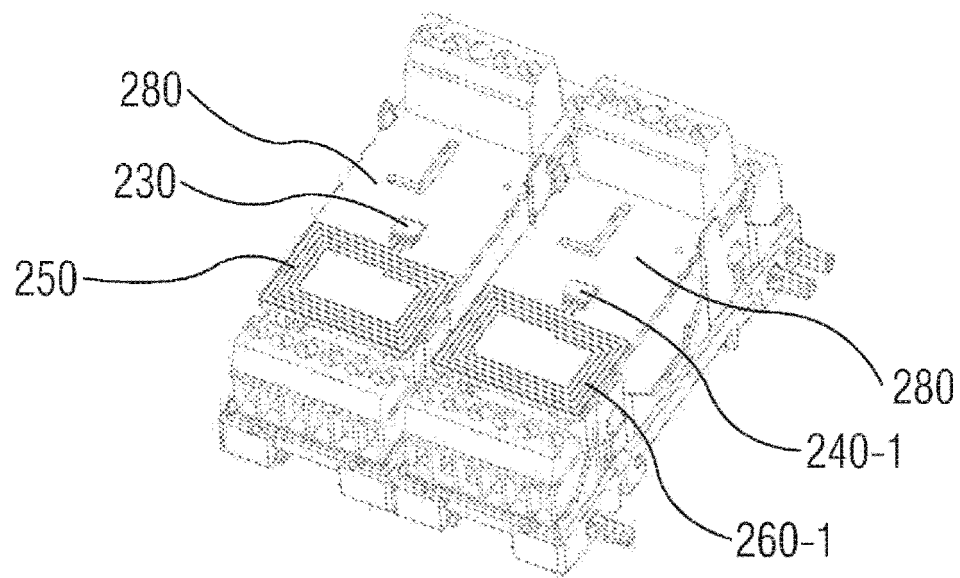


Fig. 3

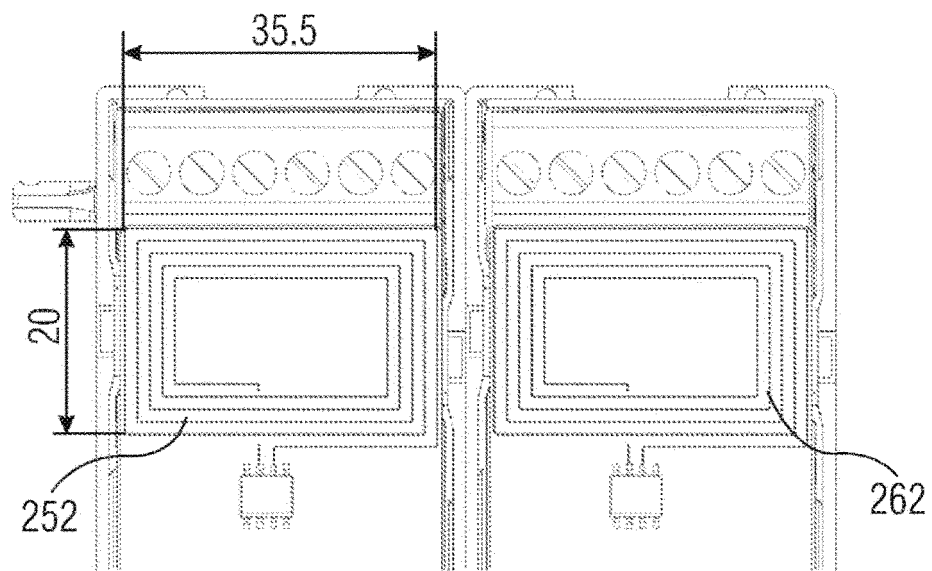


Fig. 4

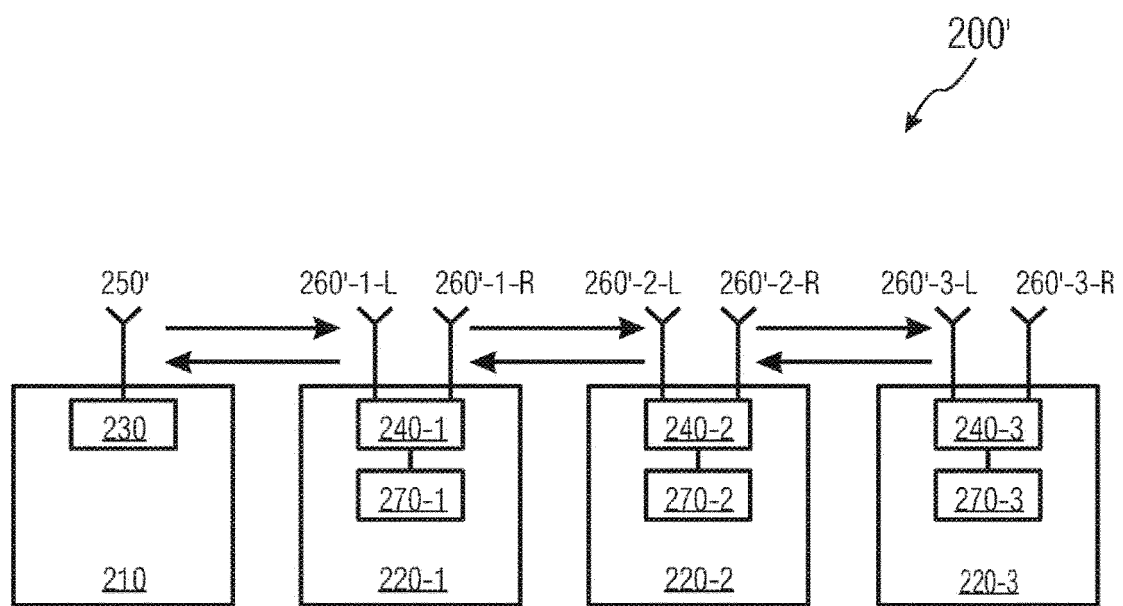


Fig. 5

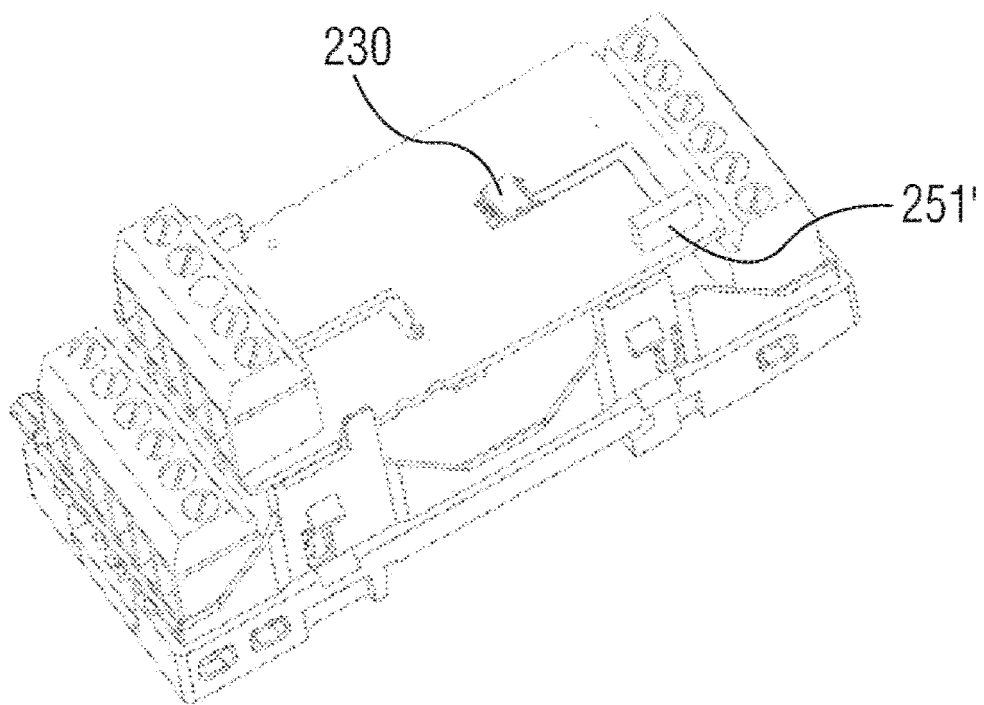


Fig. 6A

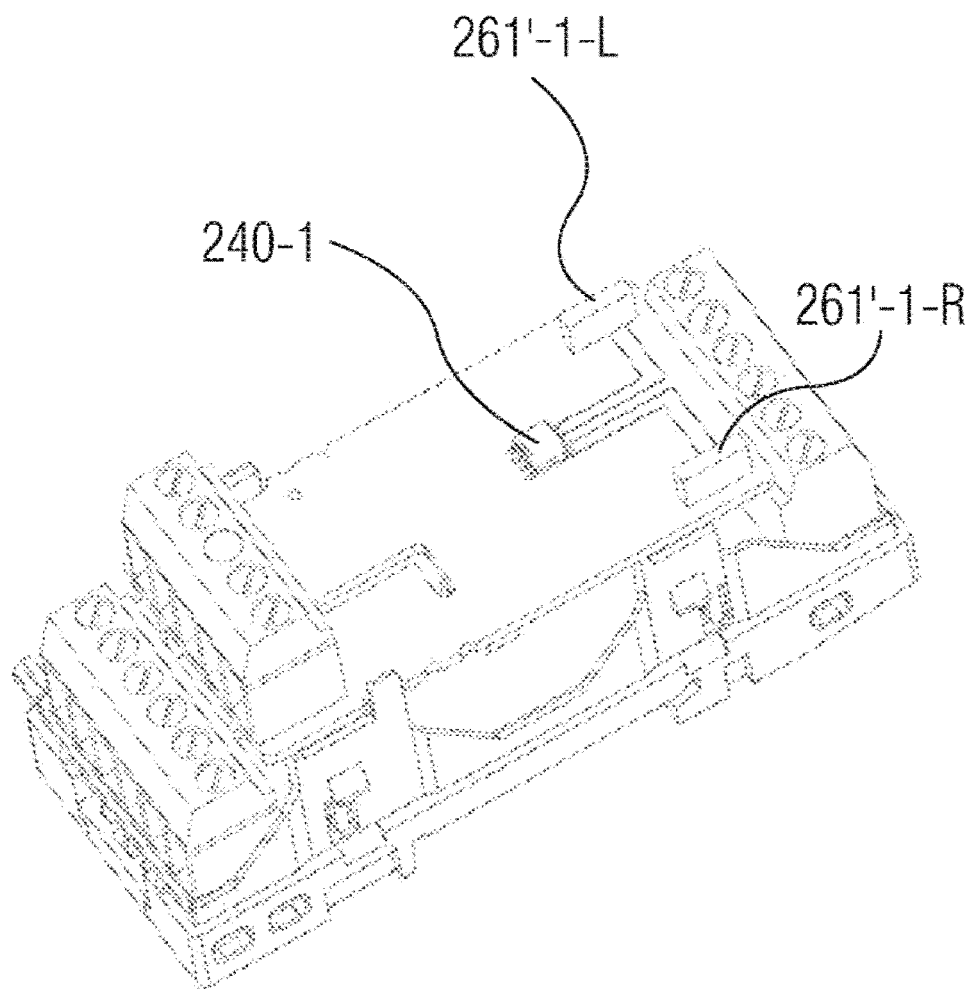


Fig. 6B

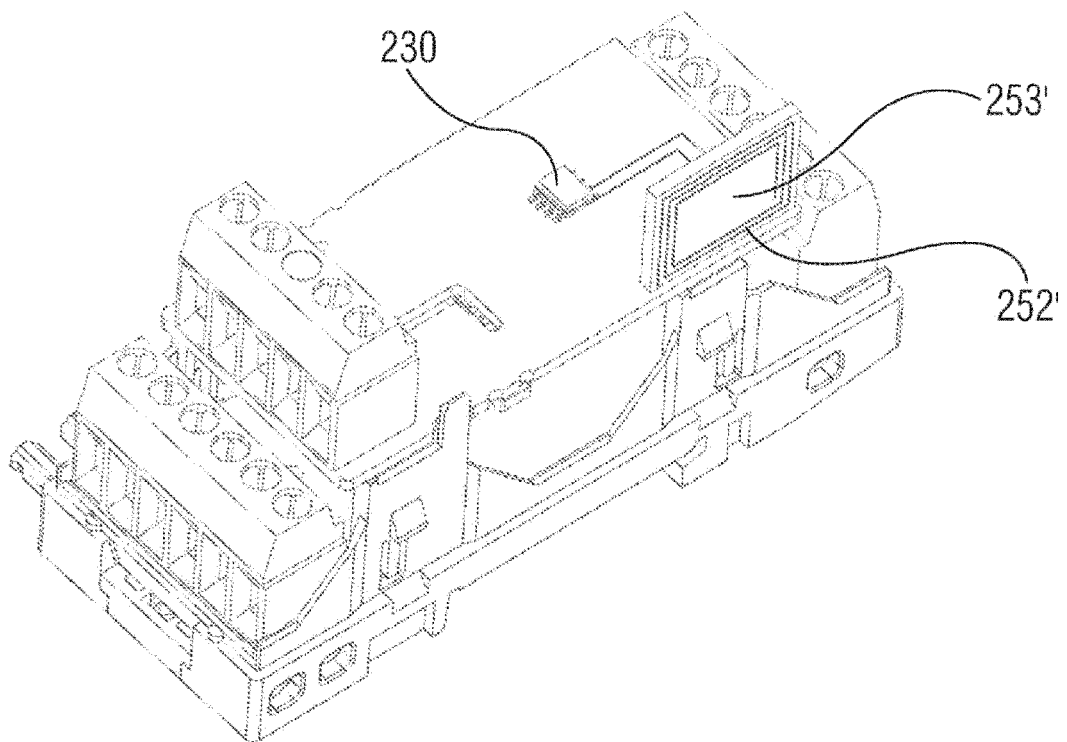


Fig. 7A

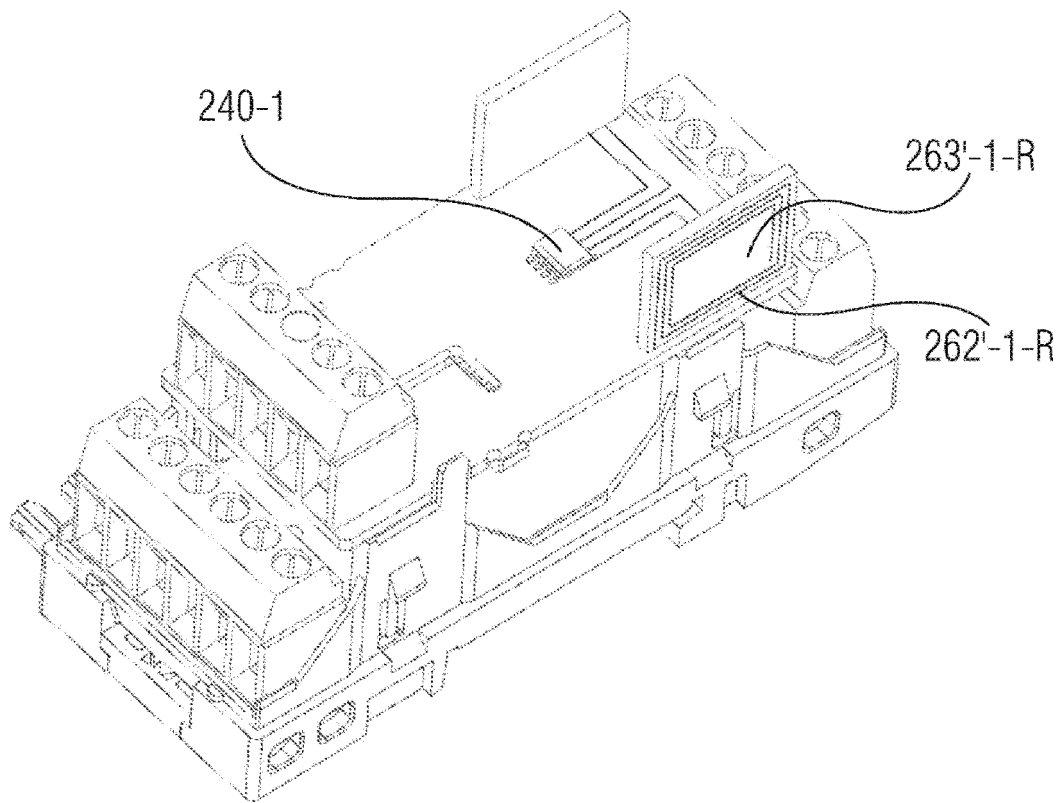


Fig. 7B

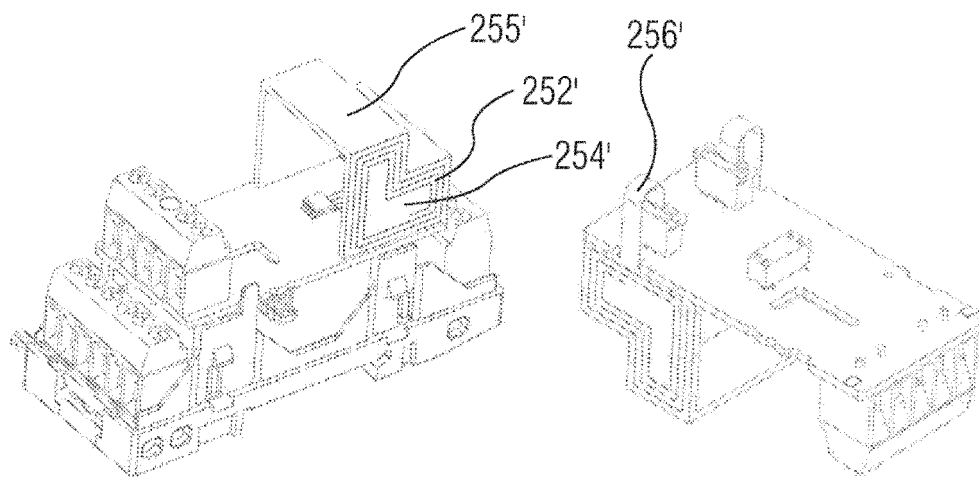


Fig. 8A

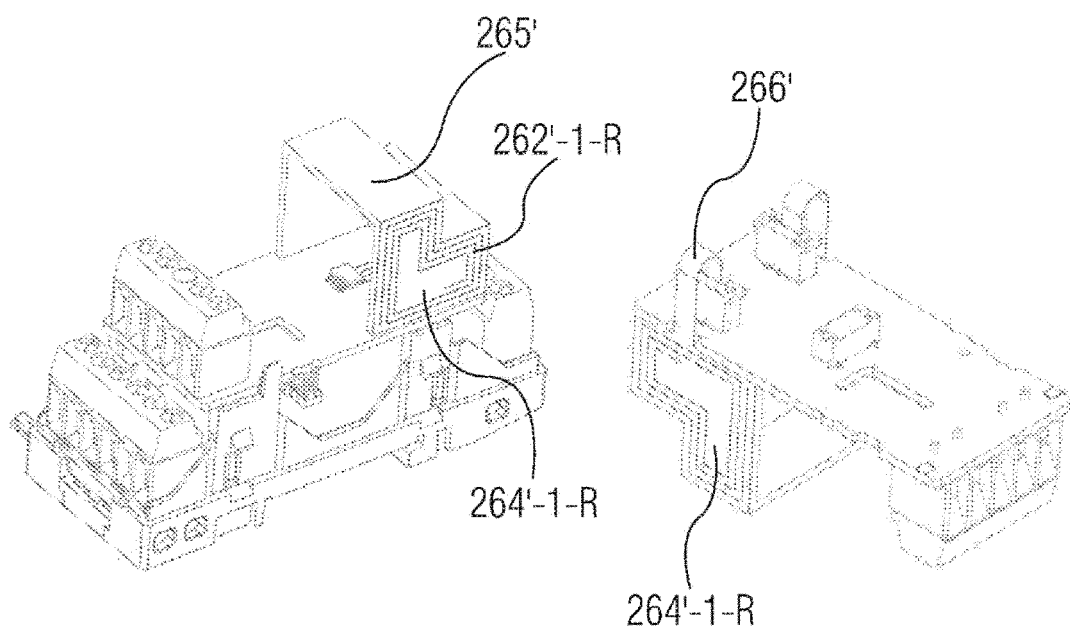


Fig. 8B

REFERENCES CITED IN THE DESCRIPTION

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